



Armed Forces College of Medicine

AFCM

Cardiopulmonary module



Cardiopulmonary module

Clinical Integrated cases
Session 6

Basic Science Principles for Clinical Reasoning



- 1- **Critical thinking**
- 2- Introduction to **common forms of disease**
- 3- **Apply basic knowledge in a realistic clinical scenario.**
- 4- **Interpersonal skills**-(think, share and apply your knowledge)
- 5- **Life long self directed learning**

*"All of life is
a constant
education."*

ELEANOR ROOSEVELT

Case co-ordinators

**Prof. Drs. Manal Hassan, Lamiaa Foad, Mohamed
Abd Elmonem**

Sharing departments

- **Chest department**
- **Physiology department**
- **Pharmacology**
- **Pathology**
- **Biochemistry**
- **Anatomy**
- **Histology**

I'm short of breath

I'm short of breath



Hussein is a **43-year-old smoker accountant** that presented to the emergency room complaining of ***shortness of breath*** (difficulty of breath). He appeared ***cyanotic***. He said he has suffered of progressive shortness of breath for the past several days.



I'm short of breath



The shortness of breath worsened and he could hardly speak. The resident put him on nebulizer containing **B2 agonist (salbutamol)**.

After 15 minutes, Hussein improved and the physician started to take history of his complaint. Hussein said "I have got a **cold**."

His cold consisted of a **sore throat**, **rhinorrhea** and **myalgia**.



I'm short of breath



At first he just felt tired but later he developed a **cough and shortness of breath**.

Initially, the **cough** was with **whitish sputum** but within 24 hours of onset, it became productive with abundant **yellow-green sputum**.



Hussein had **chronic cough mainly at the morning and progressive dyspnea** that lasted most of the winter during the past **2 years**. These attacks were associated with **wheezes**.



I'm short of breath



He smokes 1-2 packs of cigarettes/day for the past 25 years.



He often sits on a café and takes shesha

Past history: irrelevant

Family history: irrelevant



I'm short of breath



Physical examination

- The patient appears much older than the stated age.
- appears **tired** and **anxious**.
- **speaks with difficulty**, quickly becoming breathless.

Vital signs

- Blood pressure: **136/80 mmHg.**
- Pulse rate: **110/min.**
regular



Cyanosis that intensifies during coughing spells
• Temperature: **38.5°C**
• **no clubbing**
no lower limb edema

I'm short of breath



Hussein used the **accessory muscles during respiration.**

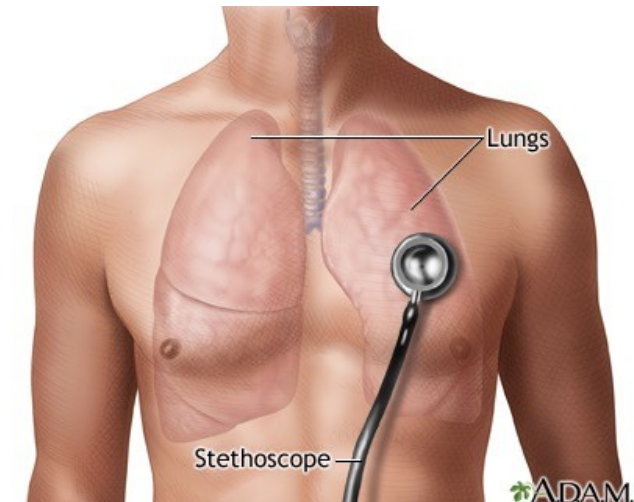
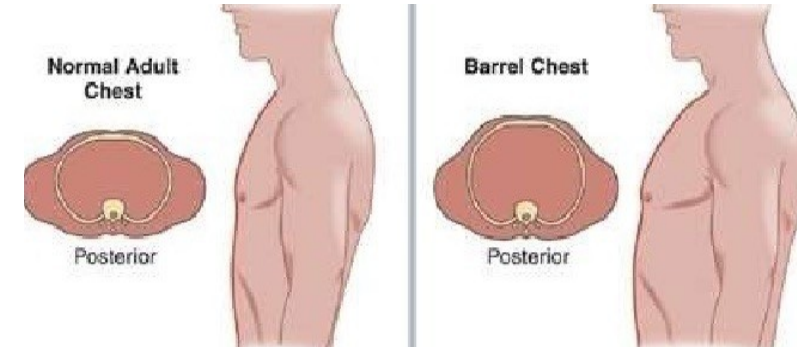
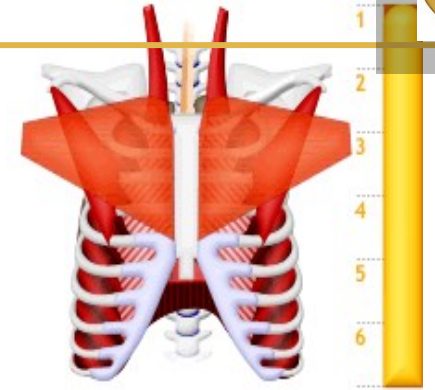
Chest examination

Increased anterior-posterior diameter of the chest

- Breath sounds are diminished **with prolonged expiration** bilaterally.
- Coarse crackles with **inspiratory and expiratory rhonchi** are heard bilaterally.



Most of these sounds clear with coughing.



Discussion

1- a- List patient problems

b- What is the differential diagnosis?

- Chest (COPD, bronchial asthma)
- Cardiac

He appeared ***cyanotic***.

2- Explain the cyanotic appearance of Hussein

Cyanosis:

- It is blueness of the skin caused by excessive amounts of deoxygenated hemoglobin in the skin blood vessels, especially in the capillaries.
- *Cyanosis appears when arterial blood* contains more than 5 grams of deoxygenated hemoglobin in each 100 milliliters of blood

Hussein cyanosis could result from:

A) Hypoxic hypoxia

Hypoventilation in chronic bronchitis and
ventilation perfusion mismatch in emphysema

B) Polycythemia

3- How to examine cyanosis?

Peripheral cyanosis in hands, ear lobules, tip of nose
Central cyanosis in under surface of the tongue

The resident put him on nebulizer containing B stimulant salbutamol.

4- What is the molecular mechanism of action of salbutamol?

a) **Stimulate β 2-receptors** $\rightarrow$ $\uparrow$ Adenylate cyclase enzyme
. $\rightarrow$ $\uparrow$ cAMP ----- Bronchodilatation

b) **Mast cell stabilization** $\rightarrow$ $\downarrow$ Release of Allergic mediators

c) $\square$ **Ciliary activity** $\square$ $\square$ bronchial mucociliary transport

After 15 min., Hussein improved and physician started to take history of his complaint. Hussein said **“I have got a cold.”**

sore throat, rhinorrhea, myalgia.

What is the interpretation of these symptoms that happened to Hussein?

ANTIBIOTICS?

When ?

Don't give antibiotics unless sputum is abundant and colored

What is more dangerous cigarettes or shisha?

5- What is the pathogenesis of chronic obstructive airway disease and its relation to smoking?

Discuss the pathogenesis of chronic bronchitis

I- Local irritation

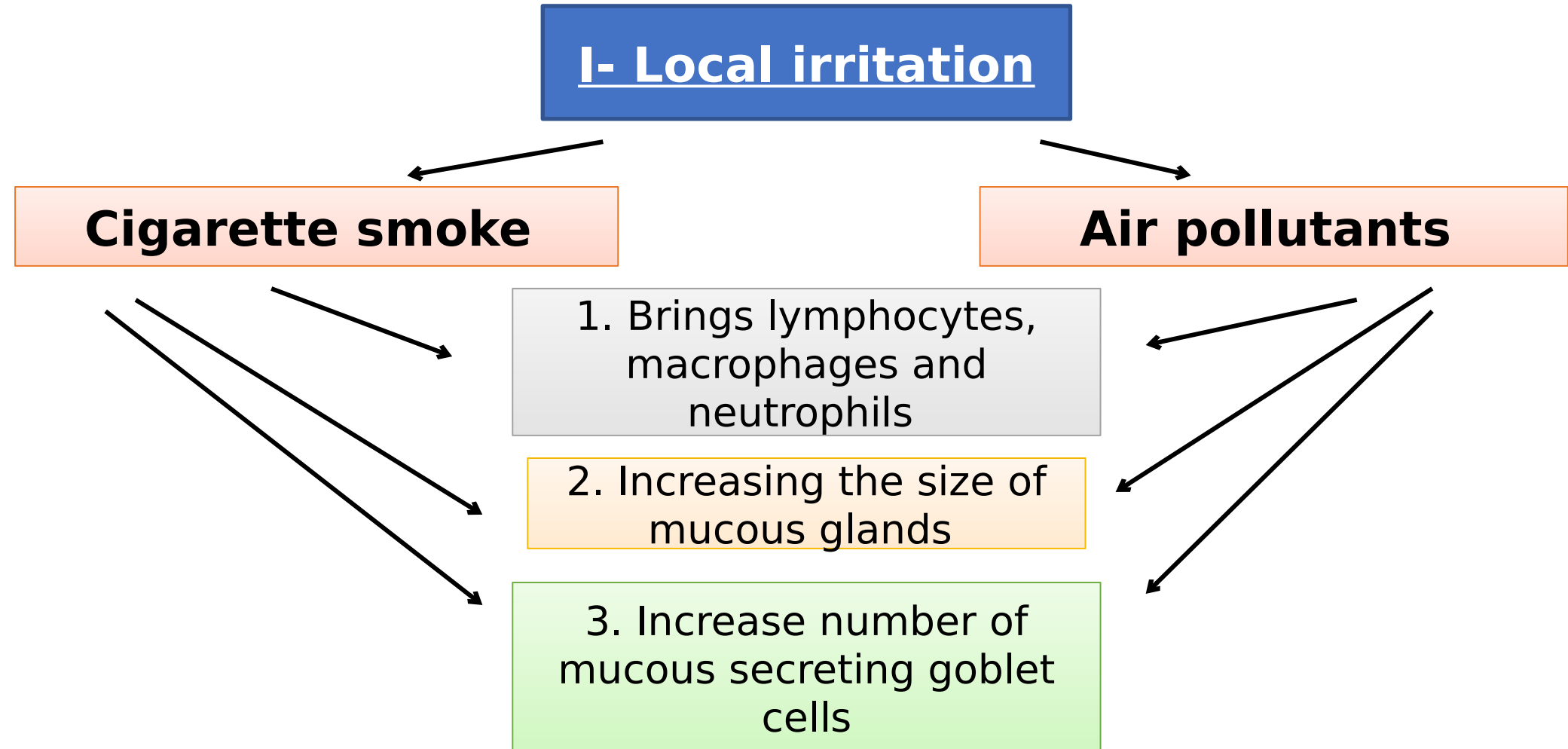
Cigarette smoke

Air pollutants

1. Brings lymphocytes, macrophages and neutrophils

2. Increasing the size of mucous glands

3. Increase number of mucous secreting goblet cells



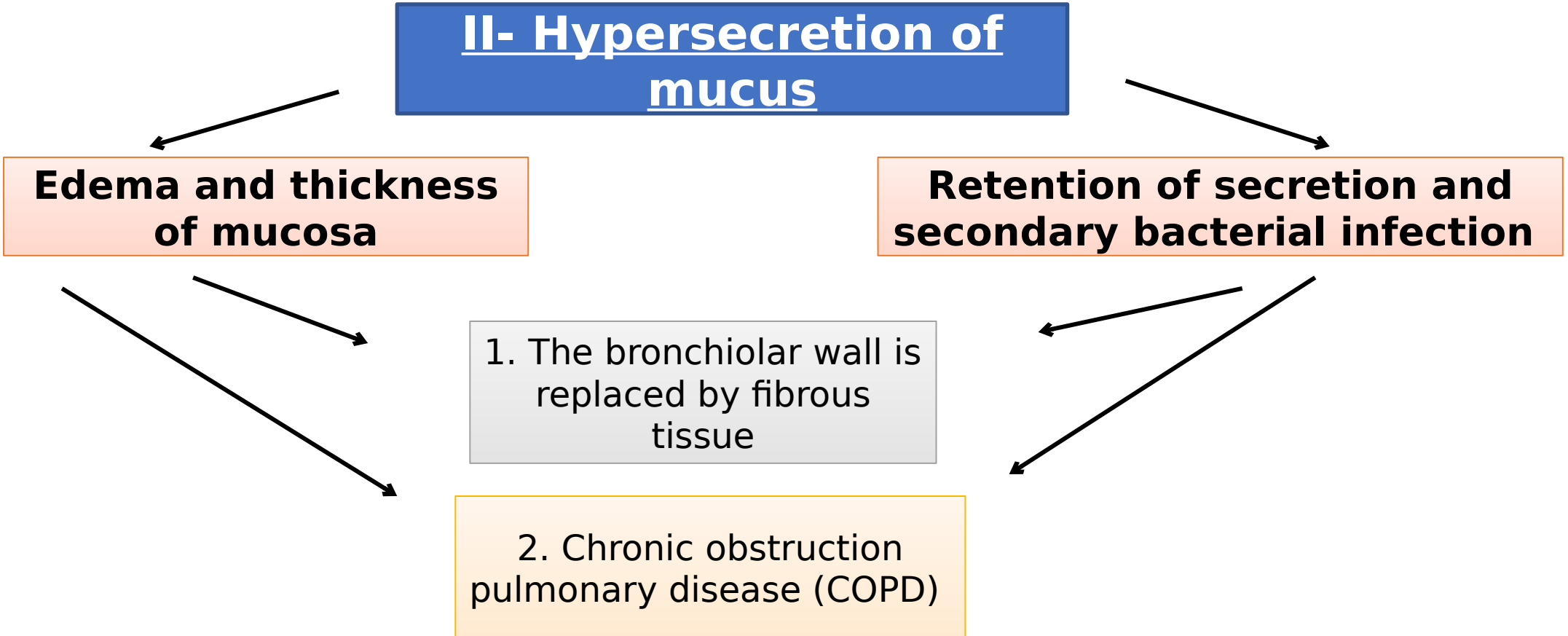
II- Hypersecretion of mucus

Edema and thickness of mucosa

Retention of secretion and secondary bacterial infection

1. The bronchiolar wall is replaced by fibrous tissue

2. Chronic obstruction pulmonary disease (COPD)

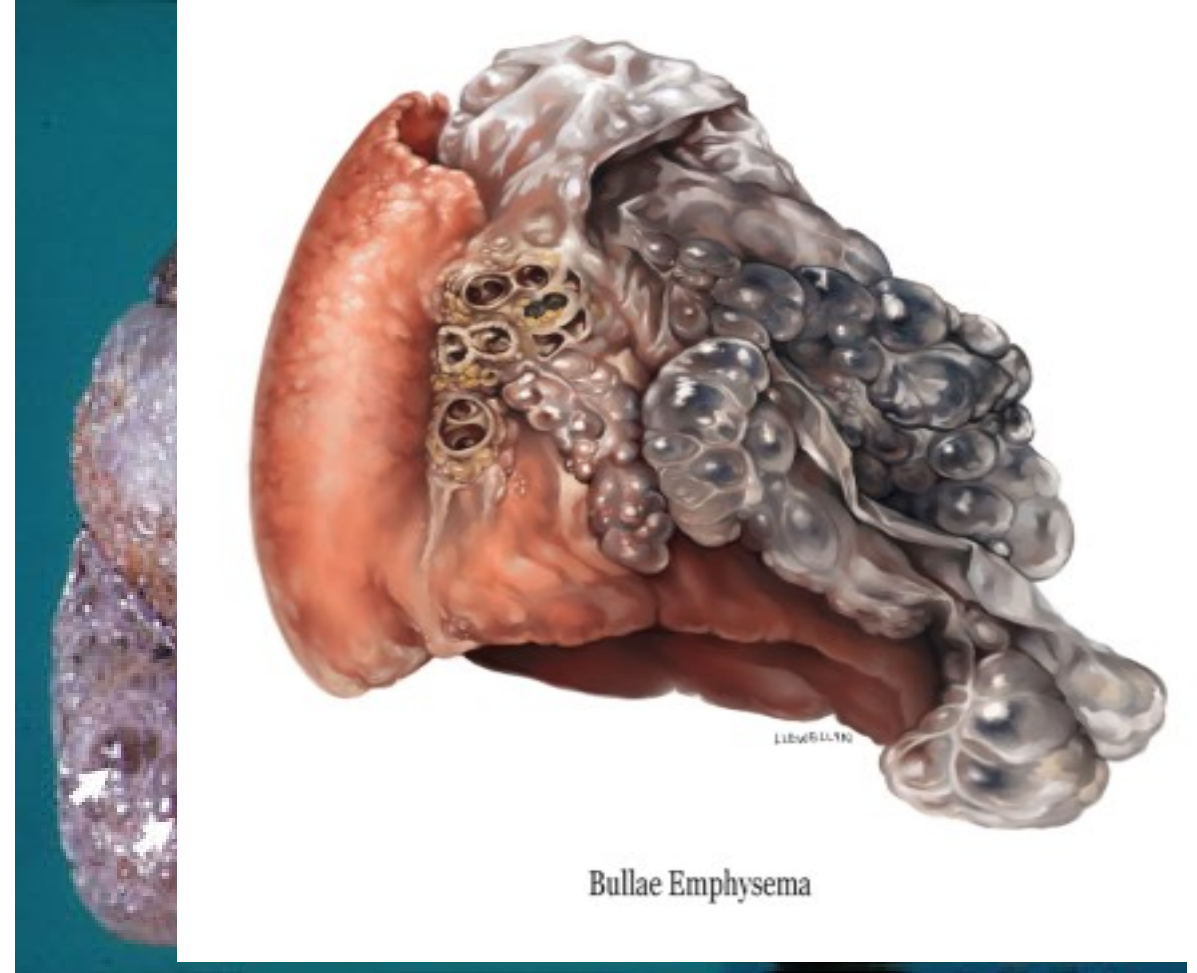


What is the gross picture of Hussein`s lungs?

Emphysema

Grossly:

- Both lungs are voluminous, fill the chest cavity and cover the heart.
- **Barrel-shaped chest** in which the anteroposterior and the transverse diameters of the chest *are equal*.
- The lung is dry, pale and light and there is indentation on their surface at the site of ribs.
- There is bullae formation along anterior border, base



1. Centriacinar:
in heavy smoker, severe in upper lobes

Emphysema



Complications:

- Dyspnea due to increased air residue.
- Spontaneous pneumothorax or interstitial emphysema from rupture of emphysematous bullae.
- Right-sided heart failure ***[cor pulmonale]*** due to pulmonary hypertension.
- Respiratory failure.

Examination of the head and neck and chest revealed the use of **accessory muscles during respiration**.

6-What are the muscles of inspiration and expiration?

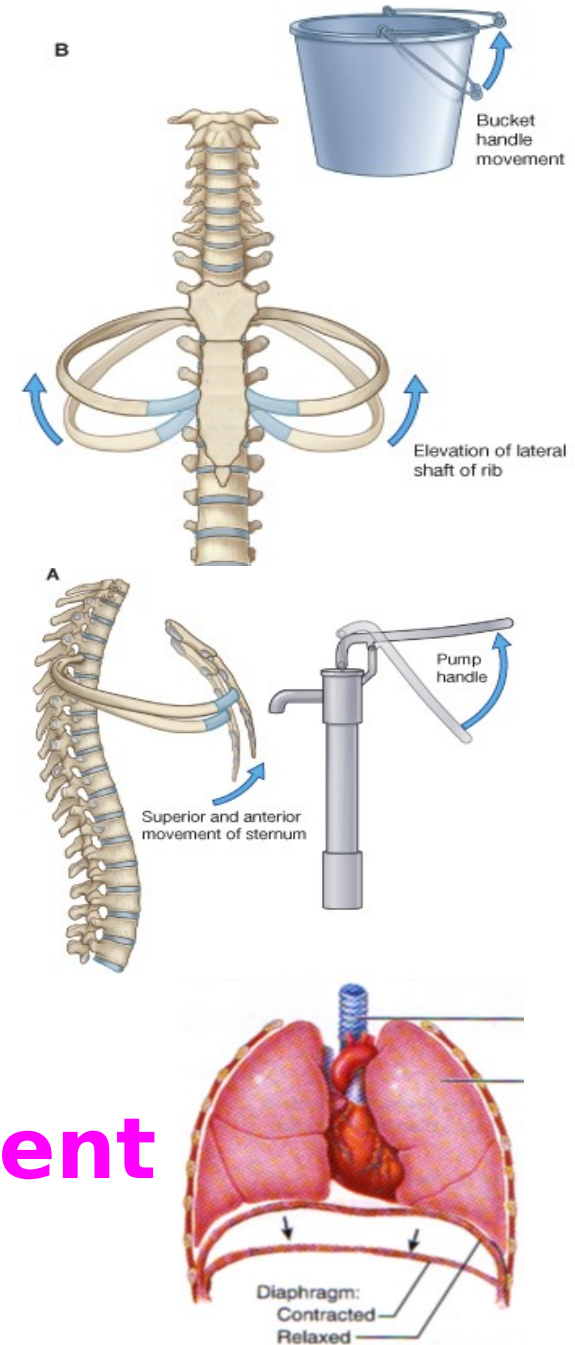
Name the accessory respiratory muscles

Movements of Respiration

Inspiration : involves increase in the 3 diameters of the thorax □ **transverse diameter/ anteroposterior diameter/ vertical diameter**

1. Transverse diameter □ increases when the ribs & their cc swing up & down like the handle of the bucket by the action of
2. Anteroposterior diameter □ increases when the sternum is pushed forwards & upwards when the anterior ends of ribs 2-7 are raised

3. Vertical diameter □ increases by descent of the diaphragm as it contracts



Types of inspiration

1. Quiet inspiration □ involves contraction of the **diaphragm & intercostal muscles** (external intercostals □ elevate the ribs)

2. Forced inspiration

➤ **Involves contraction of accessory muscles of respiration:**

a) Both in Scalene muscles □ **elevate 1st & 2nd ribs**

b) Sternomastoids □ **raise manubrium sterni**

➤ **All muscles that can raise the ribs are called into action including pectoralis major, pectoralis minor & serratus anterior.**
increase the capacity of upper part of thoracic cavity

Types of expiration

1. Quiet expiration □ a passive process caused by :

a) Elastic recoil of lungs

b) Relaxation of intercostal muscles & diaphragm

2. Forced expiration □ an active process which involves :

a) **Contraction of abdominal wall muscles** □ more increase of intra abdominal pressure □ more elevation of diaphragm

b) **Contraction of intercostal muscles which depress the ribs.**

The Respiratory Muscles

Accessory Respiratory Muscles (Inhalation)

Sternocleidomastoid muscle

Scalene muscles

Pectoralis minor muscle

Serratus anterior muscle

Primary Respiratory Muscles (Inhalation)

Diaphragm

Primary Respiratory Muscles (Inhalation)

External intercostal muscles

Accessory Respiratory Muscles (Exhalation)

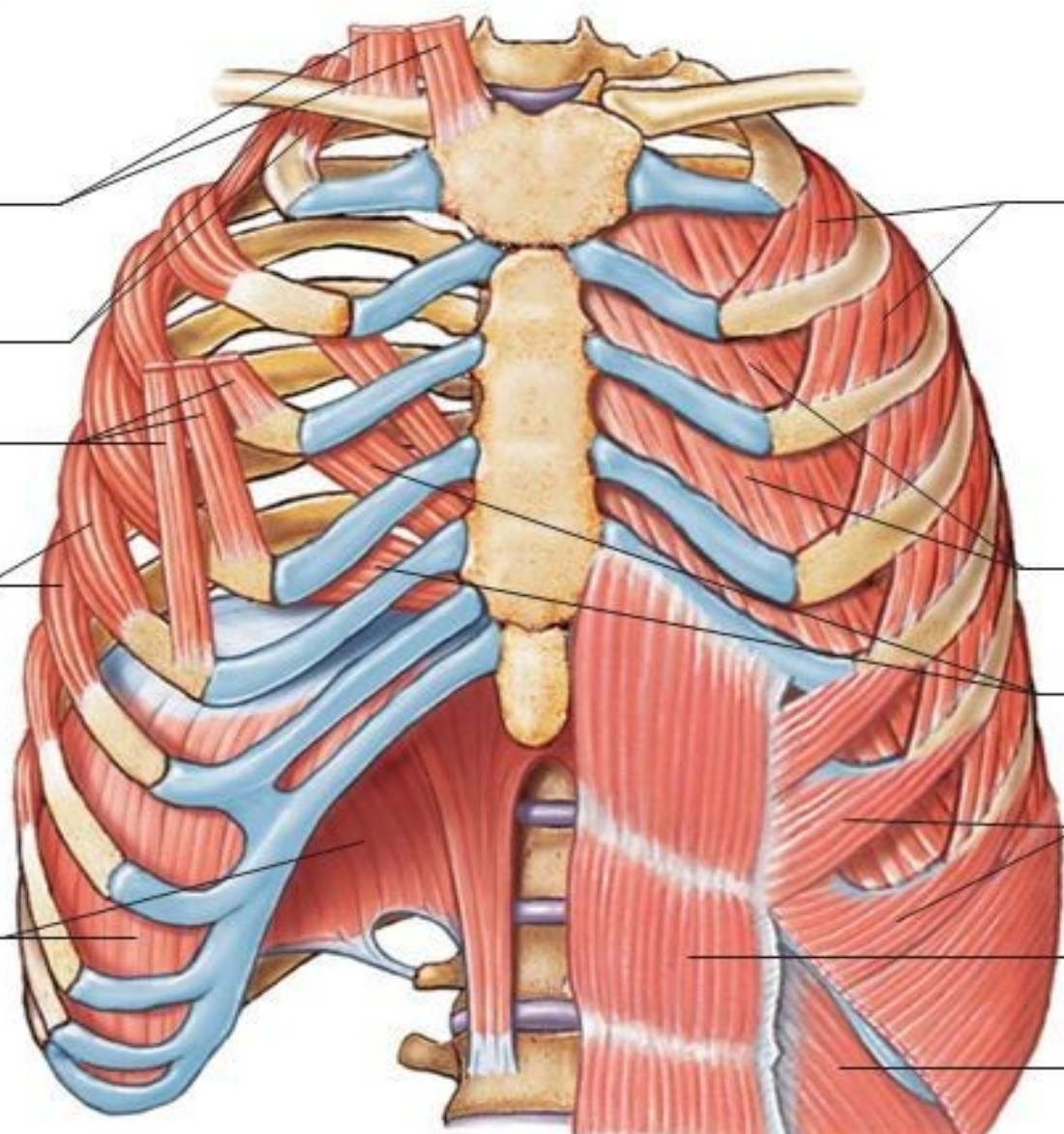
Internal intercostal muscles

Transversus thoracis muscle

External oblique muscle

Rectus abdominis

Internal oblique muscle



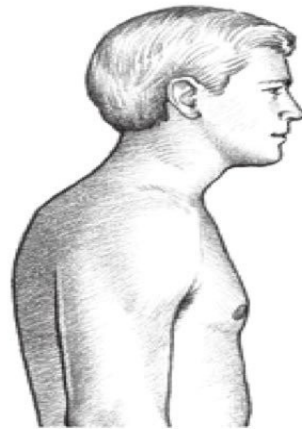
Explain why Hussein uses his accessory muscles during respiration?

- Accessory muscles are used to increase the work of breathing and generate more pressure gradient to **overcome airway resistance** in this obstructive condition
- Also, when elastic recoil is decreased, as with emphysema, **passive expiration may be inadequate to expel the volume of air** normally exhaled during quiet breathing. Thus, the abdominal muscles must work to aid in emptying the lungs, even when the person is at rest.

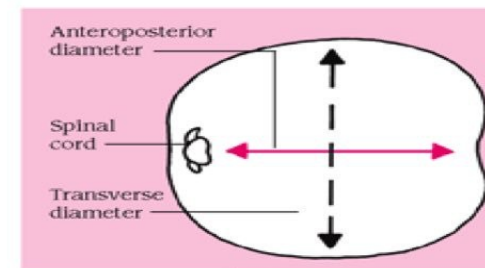
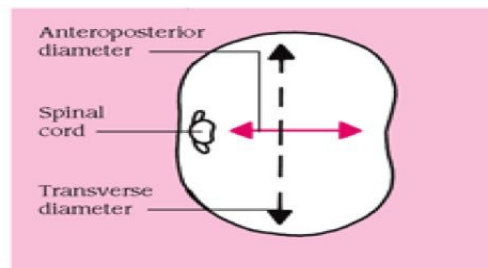
Chest examination showed increased antero-posterior diameter.

What is medical terminology of this finding?

NORMAL CHEST



BARREL CHEST



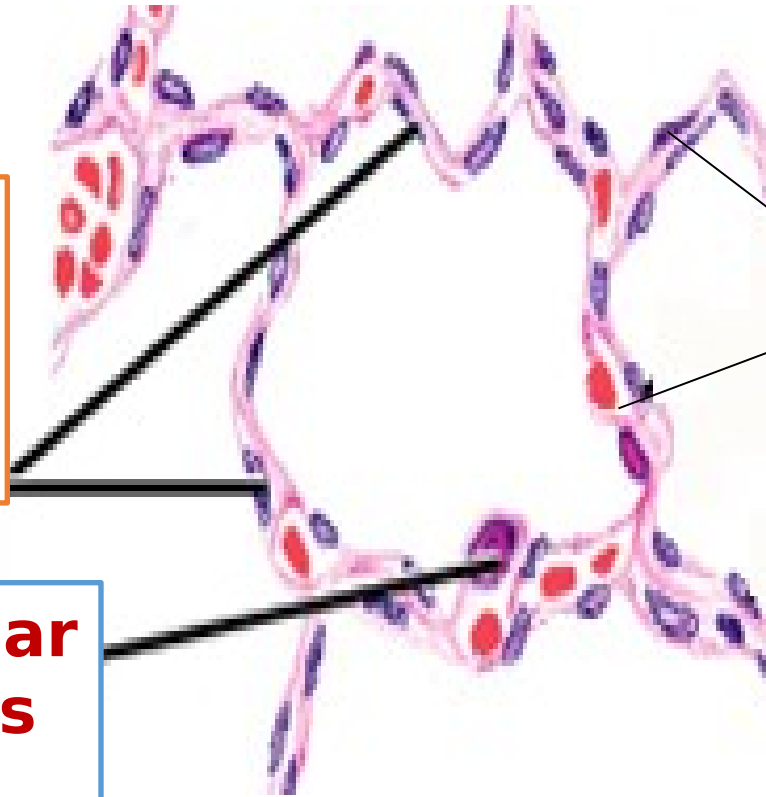
What is the structure of alveoli that is defective in Hussein?

Alveoli



- minute air spaces that open into alveolar ducts and respiratory bronchioles.
- The **basic structural and functional units** of gas exchange in the lung.

They have thin wall which allow CO₂ and O₂ exchange between blood and inspired air.



They are separated from each other by thin **inter-alveolar septa** → **highly vascular and rich in elastic fibers.**

• They are lined by **alveolar epithelium** (pneumocytes type I&II).

7- Interpret the emphysematous changes in Hussein on biochemical basis

Emphysema: A type of Chronic Obstructive Pulmonary Diseases (COPD) with damage to the lung alveoli

SMOKING DAMAGES YOUR LUNGS

Chronic obstructive pulmonary disease (COPD)

Chronic bronchitis

Emphysema

Pneumonia

Asthma

Tuberculosis



COPD CAUSES:

- ✓ Smoking
- ✓ Air pollutants / other irritants
- ✓ Genetic /epigenetic factors

SYMPTOMS OF COPD:

- ✓ Chronic cough
- ✓ Fatigue
- ✓ Dyspnea
- ✓ Production of mucus
- ✓ Shortness of breath
- ✓ Chest discomfort



Chronic bronchitis –
inflammation, excess mucus

Emphysema – alveolar
membrane degradation

Smoking and Emphysema

Methionine 358 in AAT is required for the binding of the inhibitor to its target proteases.

Smoking causes the **oxidation** and subsequent **inactivation** of the **methionine**, thereby rendering the inhibitor powerless to neutralize elastase.

Smokers with AAT deficiency, therefore, have a considerably elevated rate of lung destruction and a poorer survival rate than nonsmokers with the deficiency.

What are the investigations that should be done to Hussein?

Welcome Back

I'm short of breath



Laboratory investigations

CBC:

- Leukocyte count: 12.500/mm³
80% neutrophils, 10% bands,
28% lymphocytes, 6% monocytes, 1%
eosinophils.

- Hemoglobin: 19.8 g/dL, Hematocrit: 60%**

- Platelet count: 320.000/mm³.



After a pulse is found, a blood sample is taken from the artery

I'm short of breath



Laboratory investigations

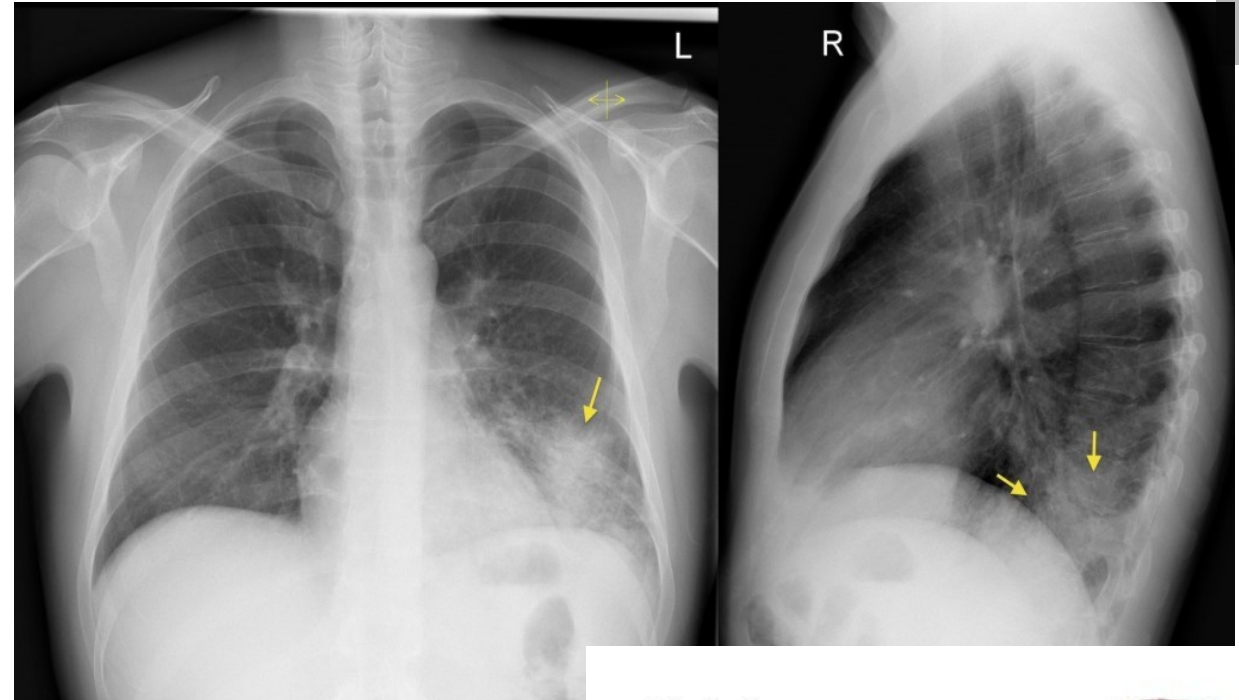
Arterial Blood Gases:

Pa O ₂	44 mmHg,
Pa CO ₂	58 mmHg,
HCO ₃	30 mEq/L.
pH	7.34



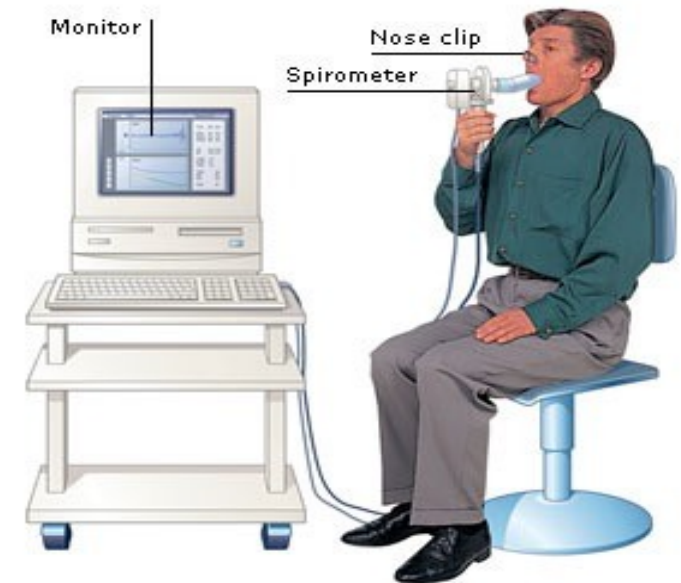
After a pulse is found, a blood sample is taken from the artery

Chest x-ray:
opacity in lower lobe
left lung



Spirometry was performed

- **FEV1: 1.1L**, Predicted = 2.9L, % of Predicted = 37.9 %
- **FVC: 3.12L**, Predicted = 3.9 L, % of Predicted = 80%
- **FEV1/FVC: 35%**



The doctor educated Hussein to

- **Stop smoking** and take
- **Plenty of fluids** and Hot fluids

▫ Inhalation therapy

Ventimask **Low flow oxygen (1-2litres 21%**



The doctor prescribed

- SABA salbutamol inhaler on exacerbation for symptom relief
- **LABA salmetrol** 2 puffs twice /day
- TheophyllineSR
- Antibiotics

Discussion

Hemoglobin: 19.8 g/dL

Hematocrit: 60%

Explain the increase in Hb and hematocrite values

- **Tissue oxygenation is the most important regulator of erythropoiesis**
- Hypoxia stimulates erythropoietin hormone production from the kidneys
- **This hormone act on EPO receptors on the bone marrow**
- It stimulates the production pro-erythroblast from erythropoietin sensitive committed stem cells
- It increases the speed of conversion of one step to the other in the erythroblastic stages, stimulating the proliferation and maturation of RBCs precursors into mature erythrocytes.

**Arterial Blood Gases of
Hussein:**

Pa O₂	44 mmHg,
Pa CO₂	58 mmHg,
HCO₃	30 mEq/L.
pH	7.34

Interpret

- ABG: **A**rterail **B**lood **G**as

Simply, know normal to discover abnormal

pH	7.35 - 7.45
PaCO₂	35 - 45 mm Hg
PaO₂	90 - 100 mm Hg
SaO₂	93 - 98%
HCO₃⁻	22 - 26 mEq/L

It is COPD that leads to **hypoxic** ($\text{PaO}_2=44$ mmHg)
and
hypercapnic ($\text{PaCO}_2=58$ mmHg) **respiratory**
failure, with partially compensated ($\text{HCO}_3=30$
mEq/L) respiratory acidosis (pH= 7.34)

Ventimask **Low flow oxygen (1-2litres 21%-22%)**

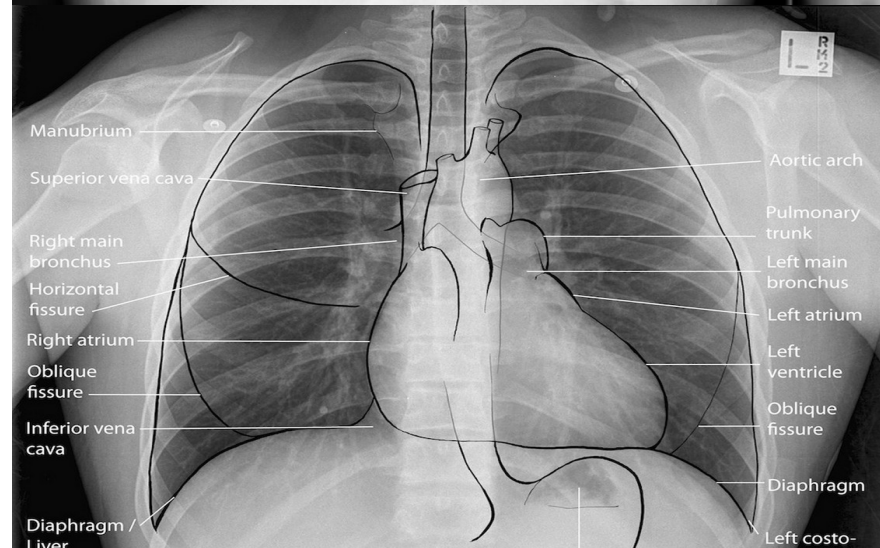
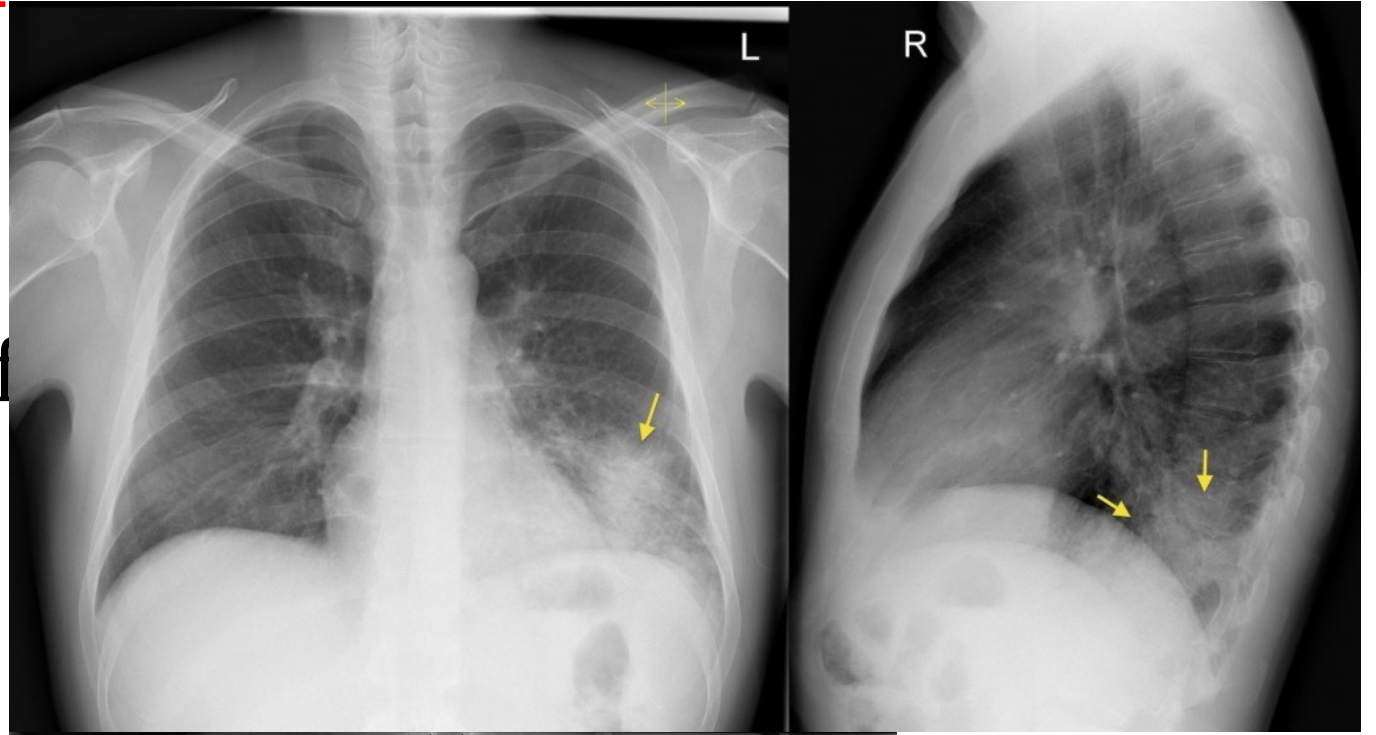
8- Explain why Hussein shouldn't be given high flow oxygen?

Don't forget an ABG in a cyanosed patient

Hypoxic drive

How can you interpret a chest x-ray?

Chest x-ray:
opacity in lower lobe left lung.



Spirometry was performed.

- **FEV1:** **1.1**L, Predicted =2.9L, % of Predicted = 37.9 %
- **FVC:** **3.12**L, Predicted =3.9 L, % of Predicted = 80%
- **FEV1/FVC:** 35%

9- a-Define FEV and FVC

b- Is Hussein an obstructive or restrictive lung disease?

- **Forced vital capacity (FVC):**

- is the volume of air that can be exhaled forcefully and rapidly after a maximal or deep inspiration. It is a dynamic lung capacity

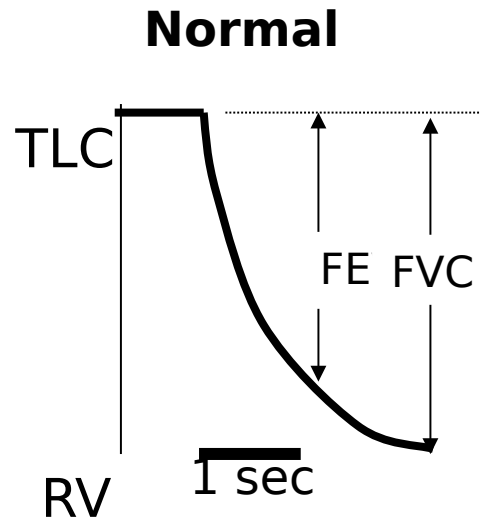
- **Forced expiratory volume (FEV):**

- is the volume of air which can be expired forcefully in a given unit of time (after a deep inspiration). It is a dynamic lung volume.

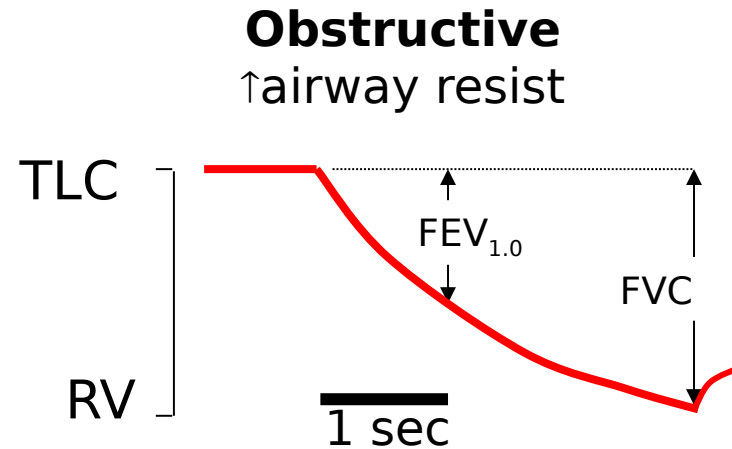
- FEV1 = Volume of air expired forcefully in 1 second (80% of FVC)
- FEV2 = Volume of air expired forcefully in 2 seconds (94%)
- FEV3 = Volume of air expired forcefully in 3 seconds. (97%)

Obstructive lung disease	Restrictive lung Disease:
Difficult expiration	They “restrict” inspiration.
FEV_{1.0}/ FVC is less than 70%	FEV_{1.0} /FVC ≥ 80%
Vital capacity decreases	Vital capacity decreases
TLC, RV, FRC increases	TLC, RV, FRC decreases
➤ Bronchial asthma ➤ Emphysema ➤ Chronic bronchitis	Fibrosis Muscular diseases

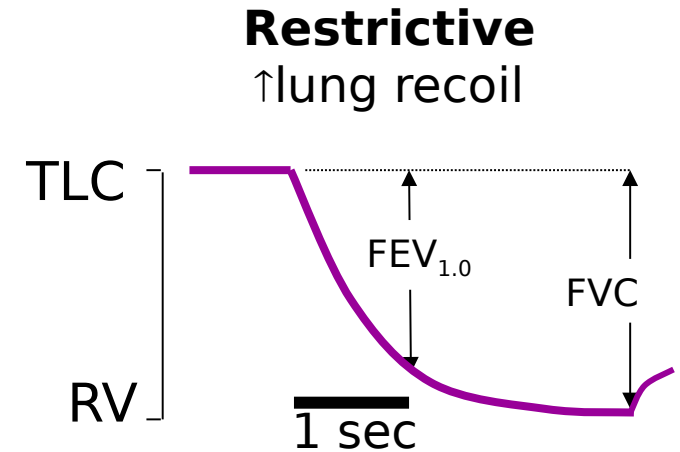
Forced Vital Capacity



FEV_{1.0} = 4 L
FVC = 5 L
% = 80%



FEV_{1.0} = 1.2 L
FVC = 3.0 L
% = 40%



FEV_{1.0} = 2.7 L
FVC = 3.0 L
% = 90%

10- Outline the management of this case

- **Symptomatic treatment**

- Bronchodilator medications are

- **Life long modification**

- central to the symptomatic

- Management of COPD.
 - The main bronchodilator treatments are anticholinergics, Beta2-agonists, theophylline, or a combination of these drugs.

- Theophylline is effective in COPD

- Bronchodilators are prescribed on an as- needed or on a regular basis to prevent or reduce symptoms.

- Long-acting inhaled bronchodilators are more convenient.

- Combining bronchodilators may improve efficacy and decrease the risk of side effects compared to increasing the dose of a single bronchodilator

What is the preferred route of administration of salbutamol?

Why salbutamol was selected as the bronchodilator of first choice?

The preferred route of administration of salbutamol?

By Inhalation

Salbutamol was selected as the bronchodilator of first choice?

It has rapid onset of action

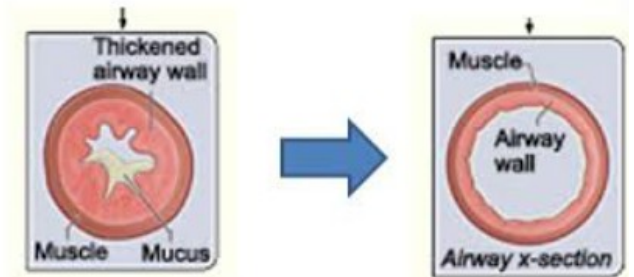
11- What is the differences between LABA and SABA?

The differences between LABA and SABA

- Variations in the molecular structure of beta agonists affect the onset and duration of bronchodilation.

	SABA	LABA
mechanism	same	
Onset	Rapid	Slow
duration	Short	Long
example	Salbutamol	Salmeterol
Uses	Rescue	Maintenance

e.g. Salmeterol
Peak Onset: 2-5 hours
Duration: 12 hours



Black Box Warning: monotherapy in asthma is contraindicated – increased risk of asthma-related deaths

What adverse effects are experienced with the use of salbutamol?

- Tachycardia
- Tremor
- Hypokalemia
- Tolerance

What is the meaning and mechanism of tolerance to β 2-agonist?

- Decrease response on chronic use of the drug
- Caused by down regulation of receptors

What is the mechanism of action of theophylline?

Methyl- xanthines

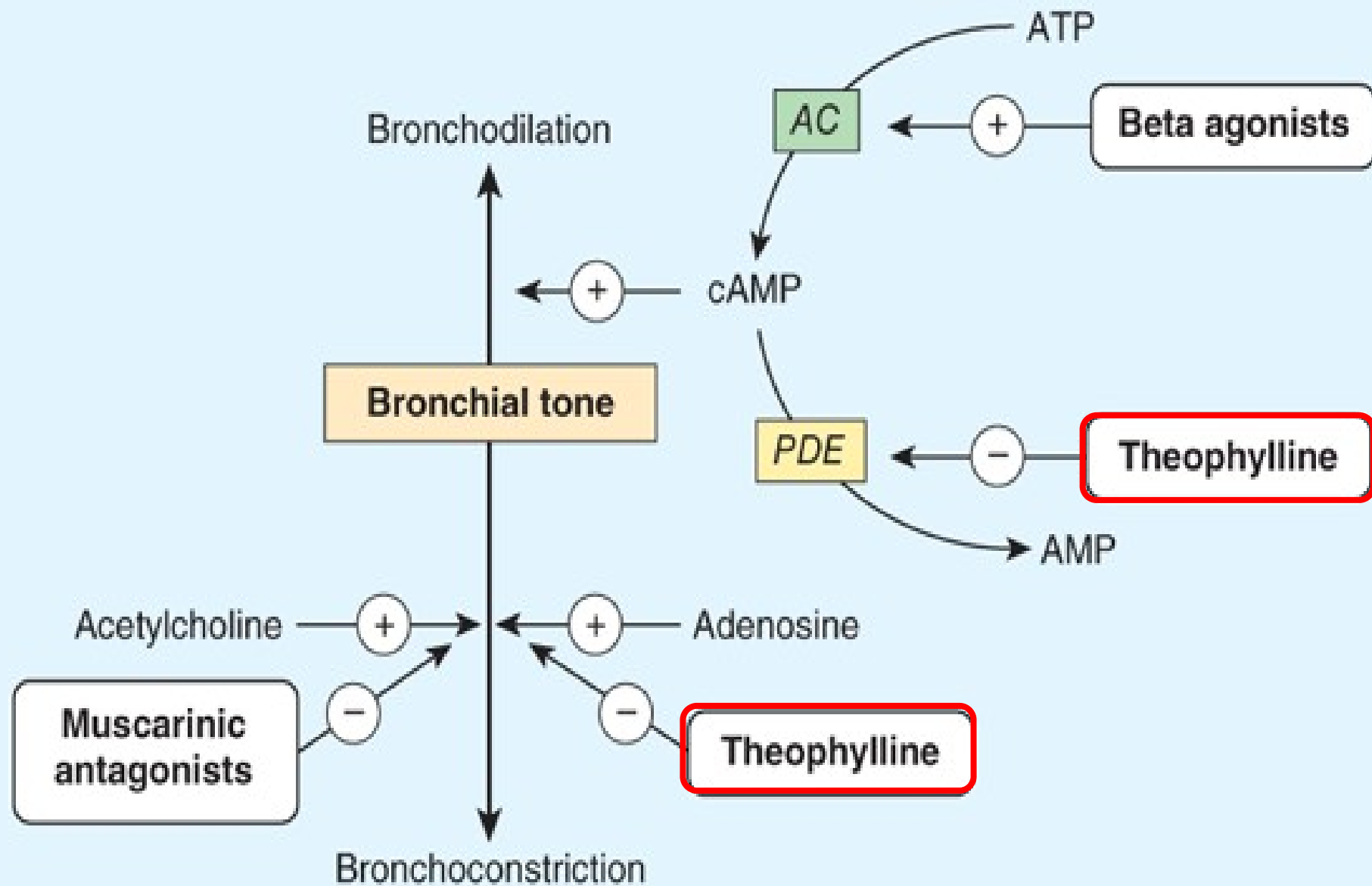
Mechanism of action

1) Phosphodiesterase enzyme (PDE₃ & PDE₄):

result in **accumulation of cellular c-AMP** → **direct bronchodilatation.**

The inhibition of PDE₄ in inflammatory cells:

the release of cytokines & cell migration.



Low therapeutic concentrations Theophylline

- In inflammatory states, theophylline activates histone deacetylase (HDAC) to prevent transcription of inflammatory genes that require the acetylation of histones for transcription to begin.
- Through this mechanism theophylline also reverses corticosteroid resistance and this may be of particular value in severe asthma and COPD where HDAC2 activity is markedly reduced.

Take home message

- 1) Avoidance of Smoking
- 2) Smoking cessation
- 3) Smoking cessation
- 4) Smoking cessation
- 5) Smoking cessation
- 6) Smoking cessation
- 7) Smoking cessation.....1000

الوقايه خير
من العلاج

Take home message

Quit smoking

- ***Infection control*** to avoid many infectious diseases.
- Treatment of URI as early as possible.
- **Avoid early use of antibiotics in viral infection but start if coloured sputum or proved pneumonia**
- Use antibiotics only when indicated



Thank
you

